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TECHNICAL MEMORANDUM

Date: 22 November 2010

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Subject: Task 3.3 – Incremental Pollutant Reduction Analysis: New Development and Redevelopment

A) Summary of New Studies Entered into the International Stormwater BMP Database
B) Summary of Research Regarding State of the Practice with Regard to Urban Stormwater BMP Monitoring

Geosyntec Project: BW0169

PURPOSE

In order to properly evaluate alternatives for stormwater management for new development, redevelopment and expansion of municipal programs (Task 3 in Evaluation of Stormwater Standards), a reasonable understanding of stormwater best management practice (BMP) performance based on monitoring of "real-world" field installations of BMPs is important. The International Stormwater BMP Database (BMP Database or Database) (www.bmpdatabase.org) project is a key resource useful for this purpose, with over 250,000 water quality records and over 400 BMPs with monitoring data. Although 30-50 new studies are typically added to the Database annually, the Project Team is aware that additional research is available that has not been entered in the Database; however, the extent of this available research has not been assessed or compiled. In this context, the purpose of this memorandum is to provide the results of a two-part effort related to acquiring and documenting the extent of currently available BMP monitoring data, including these tasks:

A) Identify, obtain and enter new BMP studies into the BMP Database, and

B) Summarize other research regarding the state of the practice with regard to urban stormwater BMP monitoring, particularly monitoring completed over the past decade.

The two tasks were completed concurrently and in a relatively short timeframe, with the primary effort focused on obtaining data for the BMP Database, with the secondary purpose being development of a general understanding of the extent of BMP research that has been conducted over the past decade, but that has not been entered into the BMP Database. This memorandum provides the scope and approach, findings and conclusions as a result of this two-part effort.

SCOPE OF LITERATURE REVIEW

During 1997-1998, the BMP Database Project Team conducted a broad literature review of BMP performance studies, resulting in identification of approximately 800 publications related to BMP performance. Further evaluation and review of these sources narrowed the list to approximately 75 studies that were considered appropriate for extraction of BMP performance data and entry into the BMP Database. Since that time, the Project Team has pursued new data for the BMP Database annually, resulting in addition of performance data for over 325 studies since that time. Growth of the Database has occurred primarily due to voluntary submission of data by researchers and agencies.

Given that the original BMP Database literature review covered research through the late 1990's, the scope of the current literature review focused primarily on the years 2000-2010 and on publications that did not overlap with the voluntarily submitted studies since 1999. Attachment 1 provides a summary of over 200 literature sources resulting from this effort. A multi-pronged approach was used to identify and obtain new research, with primary data acquisition strategies including:

- Phone calls or emails to researchers who have previously submitted data to the BMP Database or who have actively presented research findings at recent conferences such as the annual Environmental and Water Resources Institute of the American Society of Civil Engineers (EWRI-ASCE) World Water and Environmental Congresses. (In many cases, these contact yielded reports, journal papers or other published information that was ultimately included in Attachment 1.)

- Review of published literature sources.

- Review of national research center websites.

- Review of other national stormwater BMP databases.

- Phone calls to manufacturers of stormwater BMP devices.

Additional information on several of these focus areas follows in the sections below.

Literature Sources

A variety of industry journals, conference proceedings, and websites were searched for recent BMP performance monitoring studies. Keyword searches were conducted using GoogleScholar and Google to identify potential studies of interest. Although many BMP case studies existed in the

literature, the effort was targeted to studies that appeared to have event-based monitoring data of a quality generally appropriate for inclusion in the International Stormwater BMP Database. Given that the literature review was of a limited scope and timeframe, the primary sources of peer reviewed literature reviewed included:

- Water Science and Technology
- Journal of Environmental Engineering
- Journal of Irrigation and Drainage Engineering
- Journal of Environmental Quality
- Journal of American Water Resources Planning and Management
- Journal of Water Resources Planning and Management
- Journal of Environmental Science and Technology
- Water Resources
- Water Environment Research
- Journal of Hydrologic Engineering

Other journals were reviewed on a more limited basis as a result of "hits" from keyword searches including:

- Facility for Advancing Water Biofiltration (FAWB)
- Hydrology Research (formerly Nordic Hydrology)
- Journal of Hydroinformatics
- Journal of Water and Climate Change
- Journal of Water and Health
- Journal of Water Supply: Research & Technology - AQUA
- U.R.G.C. Hydrologie Urbaine
- Water Asset Management International
- Water Intelligence Online
- Water Policy
- Water Practice & Technology
- Water Utility Management International
- Water, Air and Soil Pollution

Grey literature including conference proceedings, reports and research websites were also reviewed. In particular, various conference proceedings such as EWRI-ASCE World Water and Environmental Resource Congress Conference Proceedings, StormCon (limited), and others were reviewed.

Research Centers and Programs

There are a number of stormwater research centers in various parts of the country or organizations that have large-scale BMP monitoring programs. Research centers are typically associated with universities or government agencies and tend to generate monitoring data for multiple BMPs per year, with new studies initiated periodically. In some cases, these research centers monitor real-world field installations of BMPs, but others may conduct monitoring using synthetic storms or

conduct laboratory research to optimize BMP performance processes. Although the list below is by no means all inclusive, some representative sources of this type of BMP data include:

- California Department of Transportation Stormwater Program (http://www.dot.ca.gov/hq/env/stormwater/index.htm)
- Center for Watershed Protection and Association of Watershed & Stormwater Professionals (www.cwp.org)
- Cooperative Institute for Coastal and Estuarine Environmental Technology (http://ciceet.unh.edu/)
- EPA Urban Watershed Management Research in Edison, New Jersey (http://www.epa.gov/ednnrmrl/publications/index.htm)
- Jordan Cove Research Project/University of Connecticut (Dr. John Clausen) (http://www.jordancove.uconn.edu/)
- Lawrence Technical University Great Lakes Stormwater Management Institute (http://www.ltu.edu/stormwater/)
- LID-MARC: Low Impact Development-Midatlantic Research Consortium (Traver, Hunt, Davis) (http://www.bae.ncsu.edu/stormwater/LID-MARC/index.html)
- Low Impact Development Center (http://www.lowimpactdevelopment.org/)
- Low Impact Development Mid-Atlantic Research Consortium (http://www.bae.ncsu.edu/stormwater/LID-MARC/index.html)
- National Transportation Research Board (http://www.trb.org/NCHRP/Public/NCHRP.aspx)
- North Carolina State University Stormwater Engineering Group (http://www.bae.ncsu.edu/stormwater/pubs.htm)
- Portland Bureau of Environmental Services Online (http://www.portlandonline.com/BES/index.cfm?c=34598)
- University of Central Florida Stormwater Management Academy (http://www.stormwater.ucf.edu/)
- University of Minnesota St. Anthony Falls Laboratory (http://www.safl.umn.edu/)
- University of New Hampshire Stormwater Center (http://www.unh.edu/erg/cstev/)
- Villanova Urban Stormwater Partnership (http://www3.villanova.edu/vusp/)
- Washington State University (WSU) Puyallup Research & Extension Center LID Stormwater Program (http://www.puyallup.wsu.edu/stormwater/about/)
- General websites including research associated with organizations such as ASCE (ASCE (www.asce.org), WERF (Water Environment Research Foundation) (www.werf.org), and EPA (www.epa.gov).

Many of the researchers involved in these organizations have provided BMP data in the past and/or have provided research as a result of the BMP performance data collection effort conducted concurrently to this literature review. In some cases, studies were identified, but the researcher did not choose to provide data at this time. Representative reasons why researchers may choose not to release underlying data for their research include:

- Time constraints to compile and transmit underlying data sets. For example, researchers provided a number of published reports that contained summary-level BMP performance

data, but not the underlying event-based monitoring results necessary for inclusion in the BMP Database.

- Journal submissions/publications in process (several researchers were not comfortable sharing data that they were still using for journal publications).

- Concerns regarding use of underlying event-based data by others (e.g., potential alternative presentation of data, use of data without proper citation to the original researcher).

- Other professional preferences (undisclosed reasons).

EXISTING DATABASES AND REPOSITORIES OF BMP PERFORMANCE STUDIES

In addition to the BMP Database, several other national or regional databases exist. As part of the literature review, these databases were briefly reviewed to see if significant numbers of studies might be present in those databases that are not captured in the International Stormwater BMP Database, which is the primary data source envisioned for external reasonableness checking of modeling work that will be conducted for EPA. The BMP Database has been identified for this purpose because it is the largest known single repository of BMP data across the country. Tables 1 and 2 contain a summary of the BMP types included in the BMP Database (prior to upload of studies collected as part of the current data collection effort). (Note: A subset of these studies is typically used for category-level BMP analysis, depending on the objectives of the analysis.)

Table 1.
Overview of BMP Types by Category in the International BMP Database
(October 2010)

BMP Category	Studies
Biofilter--Buffer Strip	39
Biofilter--Grass Swale	38
Bioretention	14
Composite Systems	11
Detention Basin	36
Green Roof	4
Maintenance Practice	28
Manufactured Device	66
Media Filter	35
Percolation Trench/Well	10
Porous Pavement	15
Retention Pond	61
Wetland Basin	27
Wetland Channel	16
Other	2
Total	**402**

Table 2. Distribution of BMP Types in the International Stormwater BMP Database by State (October 2010)

		BMP Category													
State	Total	BR	CO	DB	GR	GS	MD	MF	MP	OT	PP	PT	RP	WB	WC
AL	15			2			4	1					2	2	4
CA	75		1	5		40	11	11	2				2		3
CO	13							2			4		5		2
CT	1						1								
DE	9	1					7	1							
FL	81		2	3		13	11	5		1	2	9	27	6	2
GA	2			1									1		
IL	5								4				1		
MD	5			1			1							3	
MI	5			1									3	1	
MN	10		2	1									4		3
NC	15	7		1		2			2				3		
NH	16	3		1		1	7	1			1		1	1	
NJ	3						3								
NY	6			4			1	1							
OH	1										1				
OR	13			2	4	5		1						1	
PA	4	1									3				
TX	56		6	6		4	9	10			4	1	7	7	2
VA	30	1		6		11	5	1						6	
WA	23	1		2		1	3	1	12				3		
WI	12						3		8				1		
Sweden	1									1					
Ontario	1												1		
Total	402	14	11	36	4	77	66	35	28	2	15	10	61	27	16

Key: BR = Bioretention; CO = Composite System; DB = Detention Basin (dry); GR = Green Roof; GS = Biofilters (swales and strips combined); MD= Manufactured Device (multiple types); MF = Media Filters (multiple types); MP = Maintenance Practice; OT = Other; PP = Permeable Pavement (multiple types); PT = Infiltration Trench; RP = Retention Pond (wet pond); WB = Wetland Basin; WC = Wetland Channel.

Center for Watershed Protection National Pollutant Removal Performance Database

The Center for Watershed Protection (CWP) has been a repository for BMP performance studies for many years. In 1997, CWP released the "National Database of BMP Pollutant Removal Performance," which CWP updated in 2000 titled "National Pollutant Removal Performance Database for Stormwater Treatment Practices", 2nd Edition. Other studies have been compiled since that time in a technical appendix prepared for the State of Maryland for purposes of development of the Runoff-Reduction Method. In October 2010, CWP's David Hirschman and Lisa McNeal submitted an electronic copy of their most current database for inclusion in the International Stormwater BMP Database in support of this literature review effort, which included cumulative research from CWP's efforts.

To assess the extent of overlap between the CWP Database and the International Stormwater BMP Database, a comparison of studies was completed that identified approximately 76 studies that did not overlap between the databases. An additional seven studies for the City of Austin, Texas are included in the CWP Database and are partially entered into the International Stormwater BMP Database, expected to be complete in the next few months. An additional 11 studies from Florida may overlap between the databases, but differences in study nomenclature between the databases cause this to be unclear without additional review and verification.

As a result of this comparison, it is likely that a portion of the studies in the CWP Database could be appropriate for inclusion in the International Stormwater BMP Database. Additional review of the original studies would be necessary to complete this determination since it appears that a number of the non-overlapping studies in the CWP Database were included as part of the 1998 literature review for the International Stormwater BMP Database project, but were not entered into International Stormwater BMP Database. The two databases had somewhat different objectives and acceptance requirements, so it is expected that some of these studies did not meet the acceptance criteria for the International Stormwater BMP Database. For example, if the study did not provide event-based data (e.g., tabulated storm-by-storm data), then the study would not have been included in the International Stormwater BMP Database, but could have been included in the CWP Database. Based on a limited review, it is anticipated that the subset of CWP studies listed in Table 3 (at a minimum) could be beneficial for supplementing performance information in the BMP Database. These studies are focused on relatively recent bioretention and permeable pavement techniques.

Table 3.
Summary of Bioretention and Permeable Pavement Studies in CWP Database Not Currently Included in International Stormwater BMP Database

State	BMP Type	Authors/Researchers	Facility Name
Connecticut	Bioretention	Dietz, M. and J. Clausen. 2006.	Haddam Unsaturated Rain Garden
Connecticut	Bioretention	Dietz, M. and J. Clausen. 2006.	Haddam Saturated Rain Garden
Maryland	Bioretention	Davis, A.; M. Shokouhian; H. Sharma; and C. Minami. 1998.	Beltway Plaza
North Carolina	Bioretention	Hunt, W., A. Jarrett, J. Smith, and L. Sharkey. 2006.	Chapel Hill Cell C1
Wash., DC	Bioretention	Glass, C. and S. Bissouma. 2005.	Navy Yard
Maryland	Porous Pavement	Schueler, T.R. 1987.	Rockville
North Carolina	Porous Pavement	Bean, E., W. Hunt, and D. Bidelspach. 2004.	Cary
North Carolina	Porous Pavement	Bean, E., W. Hunt, and D. Bidelspach. 2004.	Goldsboro
Virginia	Porous Pavement	Schueler, T.R. 1987.	Prince William
Washington	Porous Pavement	Brattebo, B. and D. Booth. 2003.	Gravelpave
Washington	Porous Pavement	Brattebo, B. and D. Booth. 2003.	Turfstone
Washington	Porous Pavement	Brattebo, B. and D. Booth. 2003.	Grasspave
Washington	Porous Pavement	Brattebo, B. and D. Booth. 2003.	UNI Eco-Stone
Washington	Porous Pavement	St. John, M. 1997.	Cottage Lake Park - porous pavement

Florida Department of Environmental Protection

In 2006, the Florida Department of Environmental Protection (FDEP) developed a master database of BMP performance data for the State of Florida, generally modeled after the International Stormwater BMP Database. In 2007, Eric Livingston, Chief of the Bureau of Watershed Management of the FDEP, provided the Florida database for upload to the International Stormwater BMP Database. Thus, the Florida database has already been incorporated into the International Stormwater BMP Database.

(Note: A similar effort is underway by Harris County Flood Control District in Houston, TX, which has also provided several initial studies for inclusion in the BMP Database.)

EPA BMP Performance Tool

In 2008, Tetra Tech developed the Urban Stormwater BMP Performance Tool for EPA (http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmpeffectiveness.cfm) to provide summary information on BMP performance and links to underlying BMP performance studies for approximately 220 studies assessing the performance of over 275 BMPs. This tool presents information previously compiled by the International Stormwater BMP Database and by the State of California. The State of California studies were primarily obtained from the "MP Miner" database, which is predominantly non-point source oriented, including a variety of studies related to performance in agricultural areas. Additionally, a number of studies (e.g., Caltrans research) in MP Miner are also already included in the BMP Database. At this time, the MP Miner studies have not been added to the International Stormwater BMP Database. Additional review of this data set would be necessary to assess whether these studies are consistent with the BMP Database reporting protocols.

MANUFACTURERS OF PROPRIETARY PRODUCTS

A wide range of proprietary BMP products are currently on the market, with over 60 monitoring studies included in the BMP Database. However, the extent of monitoring data currently available from studies conducted in response to several national technology verification programs (e.g., TAPE, TARP, NJCAT, ETV) had not been explored prior to this literature review. Many manufacturers were contacted in late October 2010 to determine whether field-based monitoring of their products was available for inclusion in the BMP Database, provided that some form of third party involvement in the monitoring effort had occurred. Third party involvement was considered to include either data collection and analysis by a third party (e.g., university, municipality) or verification of the BMP performance through one of the national technology verification programs (listed above). Prior to contacting manufacturers, Dr. Quizong ("George") Guo, Rutgers University, was interviewed with regard to general sources of information that could be helpful with regard to characterizing availability of monitoring data for manufactured devices. Dr. Guo chairs the Manufactured Devices technical committee of the Urban Water Resources Research Council of ASCE, which has focused on development of Certification Guidelines for Manufactured Stormwater BMPs, but does not actually conduct monitoring or evaluation of these devices as part of the committee effort.

Although not inclusive of all practices currently on the market, the following vendors were contacted to determine whether monitoring data at field installations had been collected with some type of involvement from a third party. Although direct contacts were successfully completed for many of these manufacturers, in a number of cases, a voicemail was left, but not returned within the timeframe of this literature review effort. Where studies provided by manufacturers generally appear to meet the BMP Database protocols, studies provided by vendors have been listed in Attachment 1 to this memorandum. In some cases, the studies met the criteria for inclusion in the

BMP Database, but in other cases, data were not readily available in an event-based format or were based on synthetic or laboratory tests, so were not uploaded to the BMP Database.

- Abtech Industries
- Aquashield
- Baysaver/ADS
- Best Management Practices (The Snout and Bioskirt)
- Bio Clean (includes Modular Wetlands)
- Brentwood Industries (StormTank)
- Clearwater Solutions
- Contech
- CrystalStream Technologies
- Cultec
- Fabco Industries (StormSafe)
- Filterra
- Hydro International
- Hydroscreen
- Imbrium Systems
- Invisible Structures
- Kristar Enterpises
- Park Environmental (stormtrooper)
- Royal Enterprises, Ecostorm Plus
- SF RIMA (permeable pavement)
- Soil Retention (plantable concrete systems)
- StormChamber
- StormTrap
- Stormtreat
- Suntree Technologies
- Terre Hill
- Triton Stormwater Solutions
- Uni Group USA ("Eco-Stone" pavers)
- Xerxes

As a result of this research effort, in general, it appears that most manufacturers have relatively limited numbers of studies of field installations, ranging from none to perhaps half a dozen. Key sources of manufactured device information already in the BMP Database included these organizations: Caltrans, University of New Hampshire and Delaware DOT. A total of 13 new manufactured device studies were added to the BMP Database as a result of the contacts made to these manufacturers.

FINDINGS

The outcomes of the literature review and data collection effort are summarized in the remainder of this memorandum. The first outcome is the addition of 45 new BMP studies to the International Stormwater BMP Database, as summarized in Tables 4 and 5. The data set includes approximately 5,000 flow records and over 16,000 water quality records. (The data set is not attached to this memorandum due to file size.) The second outcome is identification of a significant number of additional studies that are believed to be useful for characterization of BMP performance, but that have not yet been entered into the BMP Database due primarily to timeline and limited scope of the current effort. These studies are listed in Attachment 1. Table 6 provides a brief overview of types of studies included in Attachment 1, followed by general comments regarding these studies.

Table 4. Overview of New BMP Studies Entered into the BMP Database

BMP Type	Number
Biofilter - Grass Strip	4
Bioretention	4
Biofilter - Grass Swale	1
Detention Basin (Dry)	2
Green Roof[1]	5
Infiltration Basin/Trench	2
Site Level LID	2
Manufactured Device (primarily filtration and bioretention types)	13
Permeable Pavement[1]	6
Retention Pond/Wetland Basin	5
Wetland Channel	1
Total	45

[1]Includes additional periods of record for some existing BMPs.

Table 5. New Studies Entered into BMP Database

Code	Description	ST	City	Test Site Name	BMP Name	Install Date
BI	Biofilter - Grass Strip	NC	Apex	Apex High School	15.2Apex	3/1/2008
BI	Biofilter - Grass Strip	NC	Apex	Apex High School	7.6Apex	3/1/2008
BI	Biofilter - Grass Strip	NC	Louisburg	Emergency Response Center	15.2Louisburg	3/1/2008
BI	Biofilter - Grass Strip	NC	Louisburg	Emergency Response Center	7.6Louisburg	3/1/2008
BR	Bioretention	MA	Ipswich	Partridgeberry Place	Central Raingarden	6/29/2005
BR	Bioretention	OR	Portland	Glencoe Rain Garden	Glencoe Rain Garden	9/30/2003
BR	Bioretention	WI	Madison	Madison Water Pump House	PumpHouseRainGarden	6/1/2003
BR	Bioretention	WI	Madison	Owen Conservation Park	OwenRainGarden	6/1/2003
BS	Biofilter - Grass Swale	NZ	Auckland	Albany Park and Ride NZ	AlbanyNZSwale	1/1/2007
DB	Detention Basin (Dry)	CO	Littleton	Grant Ranch	Orchard Pond	6/25/2002
DB	Detention Basin (Dry)	MA	Ipswich	Partridgeberry Place	Pond One	6/29/2005
GR	Green Roof	CO	Denver	EPA Denver Green Roof	DenverEPAGreenR	3/6/2007
GR	Green Roof	OR	Portland	Hamilton East	Hamilton East Ecoroof	9/1/1999
GR	Green Roof	OR	Portland	Hamilton West	Hamilton West Ecoroof	9/1/1999
GR	Green Roof	OR	Portland	Portland Green Roof	Portland Green Roof	9/1/1999
GR	Green Roof	PA	University Park	EPA Pennsylvania Green Roof	PennEPAGreenRoof	1/1/2005
IB	Infiltration Basin	CA	Los Angeles	LA County Sun Valley Park	Sun valley Drain and Infiltration Project	12/31/2006
IT	Infiltration Trench	MN	St. Paul	Arlington-Hamline Facility	trench5	
LD	Site Level LID	MA	Ipswich	Partridgeberry Place	Site-level LID	6/29/2005
LD	Site Level LID	WI	Cross Plains	Cross Plains LID	CrossPlainsLIDdetention	10/1/1998
MD	Manufactured Device	CA	Malibu	Marie Canyon WQ Improvement Project	Clear Creek System Disinfection	12/31/2007
MD	Manufactured Device	MN	St. Paul	Arlington-Hamline Facility	AHFinfiltrationpipe	
MD	Manufactured Device	NJ	Jersey City	Greenville Yards	GreenvilleStormfilter	7/1/2004
MD	Manufactured Device	NJ	Point Pleasant	NJ Manasquan Bank	NJManasquanCDS	11/1/2007

Code	Description	ST	City	Test Site Name	BMP Name	Install Date
MD	Manufactured Device	OR	Zigazag	Lolo Pass Road	LoloBearCreekBridgeMFS	
MD	Manufactured Device	PA	Harrisburg	Harrisburg Public Works Yard	PAYardTerreKleene	2/1/2005
MD	Manufactured Device	T	Ping-Lin (Taiwan)	Ping-Lin Parking Lot	Ping-LinParkingMCTT	9//1/2006
MD	Manufactured Device	VA	Falls Church	FallsChurchFilterra	JamesCommunityFilterra	10/1/2004
MD	Manufactured Device	WA	Bellingham	BellinghamFilterra	NorthShoreDriveFilterra	5/1/2008
MD	Manufactured Device	WA	Tacoma	Port of Tacoma Filterra 1	PortOfTacomaFilterra1	5/1/2008
MD	Manufactured Device	WA	Tacoma	Port of Tacoma Filterra 2	PortMaintenanceFilterra 2	5/1/2008
MD	Manufactured Device	WI	Madison	Madison Gas Electric Company	StormFilter	6/1/2003
MD	Manufactured Device	WI	Green Bay	St Mary's Hospital Green Bay	PressureFilter	12/1/1998
PC	Porous Pavement - Pervious Concrete	CO	Lakewood	Lakewood Shops	LakewoodPC	4/12/2005
PF	Permeable Friction Course	TX	Austin	Texas PFC 1	AustinTX1PFC	11/1/2004
PF	Permeable Friction Course	TX	Austin	Texas PFC 2	AustinTX2PFC	1/1/2004
PF	Permeable Friction Course	TX	Austin	Texas PFC 3	AustinTX3PFC	11/1/2004
PM	Porous Pavement - Modular Blocks	CO	Denver	Denver Wastewater Building	DenverWWPC	5/12/2008
PM	Porous Pavement - Modular Blocks	NZ	Auckland	Birkdale Rd NZ	BrickdaleNZPP	2/1/2006
RP	Retention Pond (Wet)	CA	Sacramento	North Natomas Water Quality Basin 4	Natomas Basin 4	1/1/1999
RP	Retention Pond (Wet)	CO	Denver	Orchard Detention Pond	OrchardDetentionPond	6/1/1998
RP	Retention Pond (Wet)	CA	Alameda	Heron Bay	Heron Bay Pond	
RP	Retention Pond (Wet)	MN	St. Paul	Como Park Watershed	ComoDetentionPond	10/1/2007
WB	Wetland Basin	CA	Los Angeles	LA County Dominguez Gap Wetlands	Dominguez Wetlands	
WC	Wetland Channel	MN	Roseville	Villa Park MN	VillaParkWetlands	6/1/1985

Table 6. Overview of Types of BMP Studies Identified in the Literature Review

BMP Type	Estimated Number of BMP Data Sets Potentially Appropriate for Inclusion in BMP Database[1]
Bioretention	60
Vegetated Conveyance BMPs (Swales/Strips Wetland Channels, Biofilters)	25
Green Roofs	30
Permeable Pavement	30-75[2]
Retention Ponds (wet)	10
Detention Pond (Dry Extended Detention Ponds)	10
Media Filters (non-proprietary)	<5
Manufactured Devices	30
Infiltration Basins/Trenches	20
Site-scale LID	5
Rainwater Harvesting	<5
Street Sweeping	<5
Total	**>230**

[1]Forty-five studies from this list have been entered into the BMP Database, as summarized in Tables 4 and 5.
[2]One study in Spain includes 45 sites; additional review of this study would be needed to assess appropriateness for inclusion in the BMP Database.

Although synthesis and further evaluation of these studies would be a valuable effort, this level of review is beyond the current scope of this memorandum. Nonetheless, a few general observations include:

- **Bioretention:** Although the number of bioretention data sets included in the BMP Database has grown over the last two years, a significant number of bioretention studies are believed to be available and should be pursued for inclusion in the BMP Database.

- **Permeable Pavements**: Relatively few permeable pavement studies have been included in the BMP Database. It appears that a number of permeable pavement studies could be added to the BMP Database based on the literature review. International data sets appear to be particularly relevant to this category. Pursuing additional studies would be desirable to enable category-level analysis of this BMP type.

- **Green Roofs**: Based on the literature review, monitoring data for green roofs in the United States appear to be primarily located in high rainfall, humid areas on the East and West

Coasts. A notable exception is the EPA Green Roof building in Denver, CO, which has a monitoring program in place with some limited data available. New Zealand and several European countries also appear to have green roof monitoring data.

- **Manufactured Devices**: The types of manufactured device studies appear to be broadening to include filtration practices and manufactured systems intended to function similarly to bioretention facilities. While many manufactured device designs have historically focused primarily on sedimentation processes, a number of new devices are on the market targeting bacteria, nutrients and volume reduction, including unit treatment processes expanding beyond sedimentation.

- **Wet Ponds/Wetland Basins/Detention Ponds**: Although new studies are available in these categories, the existing stormwater BMP Database is relatively strong in these areas, so these studies may be a secondary priority for data acquisition relative to some other BMP types.

- **Rainwater Harvesting**: Although various papers exist regarding the multi-purpose benefits of rainwater harvesting, quantitative studies based on site monitoring for the purpose of evaluating site water balances appear to be limited.

- **Site-level LID Studies**: A relatively small number of site-level LID studies with readily available event-based monitoring data appear to be available. Two site-level LID studies were added to the BMP Database as a result of the current effort (Partridgeberry Place, MA and Cross Plains, WI). Two others (Jordan Cove, CT and Puget Sound, WA) were obtained, but have not yet been entered due in part to data summary formats that required additional processing. Based on this literature review, perhaps half-a-dozen site-level studies with event-based monitoring data are known to exist. Additional research to target other studies that may be available would be valuable, perhaps in conjunction with the Center for Low Impact Development. While other studies are suspected to be available beyond those identified in this literature review, site-level LID monitoring is expensive and challenging to conduct, so it appears to be more common for monitoring data to be collected for individual BMPs/LID practices within a site, as opposed to monitoring the site as a whole.

In addition to the studies obtained or entered into the BMP Database, another important finding of the literature review included identification of significant stormwater BMP monitoring efforts that are underway; however, data may not yet be available. Based on follow-up phone calls to researchers as a result of information identified in various literature sources, the following on-going data collection efforts may be helpful within the next year to two:

- **Seattle Public Utilities**: Three green roofs of differing sizes are being monitored. One roof has data available, one will have data available in December 2010, and the one is expected to be complete by the end of 2011. The data sets for these sites are continuous records that will be suitable for use in modeling. Synthesis of the data is expected in late 2011. Per communication with Joel Banslaben at Seattle Public Utilities, these data sets will be submitted to the BMP Database (Personal Communication with Joel Banslaben).

- **Johnson County, Kansas**: A series of BMPs have been installed and are being monitored. Data are not yet available. (Personal Communication with Lee Kellenberger, Johnson County Public Works)

- **Kansas City Area:** Green Infrastructure BMPs are being constructed in the Kansas City area to address Combined Sewer Overflow (CSO) issues. Due to delays in construction, monitoring data were not yet available at the time of this literature review (Personal Communication with Scott Struck, Tetra Tech).

- **Lake Tahoe, CA:** A database is being developed by several entities for the Lake Tahoe watershed area, with data currently under review. Alan Heyvaert at the Desert Research Institute is the primary contact for this effort. (Personal Communication with Marc Leisenring, Geosyntec Consultants).

- **Washington State Department of Transportation (WSDOT):** WSDOT recently completed an extensive internal review and update of its Quality Assurance Project Plan (QAPP) related to BMP monitoring. BMP monitoring is underway, but not yet available to the BMP Database.

- **California Department of Transportation (Caltrans):** Caltrans maintains an extensive water quality database that was in the process of transition at the time of the Team's recent data request. Caltrans is known to have BMP monitoring in the Lake Tahoe area that is not currently included in the BMP Database.

- **Australia**: Several researchers in Australia are known to be actively conducted stormwater BMP monitoring and have expressed interest in the BMP Database.

CONCLUSIONS

1. A substantial amount of BMP monitoring research has been conducted in the last decade. Many, but not all, of the key research efforts have been entered in the International Stormwater BMP Database. As a result of this literature review, 45 additional studies were entered into the database.

2. The most active portions of the country for field-scale BMP monitoring appear to be the East and West Coasts, particularly California, Washington, Florida, North Carolina, New Hampshire. For the central portion of the country, Texas, Colorado and Minnesota appear most active. Universities and departments of transportation are key data sources.

3. A significant amount of research is ongoing or has been conducted in the past decade related to optimization of BMPs through either laboratory research or synthetic stormwater field tests. This includes both non-proprietary and proprietary products. The scope of this literature review focused primarily on field installations, but this ongoing laboratory research is important with regard to optimizing BMP performance and designs that are sustainable over the long-term. Just two examples include work by Clark and Pitt (2010) to optimize media in bioretention cells for

the purpose of removing certain pollutants. Other research by Guo (2010) in the Denver area focused on alternative infiltration media that can incorporate a variety of recycled materials and reduce reliance on media such as peat. While these types of studies are not entered into the BMP Database, compilation of this research could be instrumental in better understanding the effectiveness of unit treatment processes in BMPs.

4. A substantial amount of research is available that has not yet been integrated into the International Stormwater BMP Database. Although additional review of the identified studies would be needed to determine an exact number of studies meeting the BMP Database criteria, the number of studies is estimated to be along the lines of 230 or more BMP data sets. Some data sets are part of ongoing/new research efforts, whereas other data sets are being retained by researchers who are currently using their data for purposes of journal submissions and publications and choose to retain the data until the journal acceptance process is completed. These will be important data sets to obtain in the future. Although the timing of availability of these studies may extend beyond EPA's current objectives, some of these studies could become publically available within the next six months.

Attachment

Attachment 1 Summary of New BMP Performance Monitoring Studies

Attachment 1. Literature Review Summary

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Evaluation of the accumulation of sediment and heavy metals in a storm-water detention pond	Water Science & Technology Vol 45 No 7 pp 105–112	Journal	Färm, C.	2002	Central Sweden	1	Detention Pond		
Experimental investigation of runoff reduction and sediment removal by vegetated filter strips	Hydrological Processes Volume 18, Issue 11, pages 2029–2037, 15 August 2004	Journal	Abu-Zreig, M., R.P. Rudra, M.M. Lalonde, H.R. Whiteley, N.K. Kaushik	2004	-	20*	Filter Strip	Synthetic runoff conditions @ 2700 mg/L at different vegetated filter strip lengths, oriented to crop runoff. (*Note: BMP Database does not currently analyze studies resulting from synthetic storms or lab research.)	
Legacy LID: Stormwater Treatment in Unimproved Embankments along Highway Shoulders in Western Washington	International Low Impact Development Conference, November 16-19, 2008	Conference	Ahearn, D. and R. Tveten	2008	WA	1*	Bioretention	Highway Embankment/Infiltration slope [study abstract suggests 4 sites, but 1 study provided previously provided to BMP Database]	Yes (prior to fall 2010)
Grassed swales for stormwater pollution control during rain and snowmelt	Water Science & Technology Vol 48 No 9 pp 123–134	Journal	Bäckström, M.	2003	Northern Sweden	*	Grass Swales	Number of sites monitored not specified in abstract; previous year's publication suggests simulated storms	
Sediment transport in grassed swales during simulated runoff events	Water Science & Technology Vol 45 No 7 pp 41–49	Journal	Bäckström, M.	2002	Sweden	9*	Grass Swales	Simulated Runoff	
Permeable pavements: pollution management tools	Water Science & Technology, Vol 32 No 1 pp 49–56 © IWA Publishing 1995	Journal	Baladès, J.D., M. Legret and H. Madiec	1995	Bordeaux, France	1	Permeable Pavement		
Report on the Environmental Benefits & Costs of Green Roof Technology of the City of Toronto	City of Toronto	Report	Banting et al (City of Toronto/Ryerson University)	Jun-05	Toronto, Ontario	Literature Review	Green Roof	May include other references with data.	
The purification performance of infiltration basins fitted with pretreatment facilities: a case study	Water Science & Technology, Vol 43 No 5 pp 119–128	Journal	Bardin, J.P., A Gautier, S. Barraud and B. Chocat (U.R.G.C. Hydrologie Urbaine)	2001	Lyons, France	1	Infiltration Basin		
Statistical analysis of pollution in stormwater infiltration basins	Water Science & Technology Vol 51 No 02 pp 1–9	Journal	Barraud, S., M. Dechesne, J.-P. Bardin and J.-C. Varnier	2005	Lyon, France	4	Infiltration Basin		
Evaluation of the Performance of Permanent Runoff Controls: Summary and Conclusions	Center for Transportation Research, The University of Texas at Austin, Project Summary Report 2954-3F	Report	Barrett, M. E., M. V. Keblin, P. M. Walsh, J. F. Malina, Jr., and R. J. Charbeneau (UT Austin, Center for Water Research)	1997	TX	3*	Swale, Pond, Buffer Strip	Already in BMP Database.	Yes (prior to fall 2010)
Performance, Cost, and Maintenance Requirements of Austin Sand Filters	Journal of Water Resources Planning and Management, Vol. 129, No. 3, May/June 2003, pp. 234-242	Journal	Barrett, M.E. (UT Austin)	May-03	CA	5*	Sand Filters	Already in BMP Database.	Yes (prior to fall 2010)
Performance and Design of Vegetated BMPs in the Highway Environment	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2004	Conference	Barrett, M.E. (UT Austin)	2004	CA	8*	Grass Swales	Roadside Swales. Already in BMP Database.	Yes (prior to fall 2010)
Stormwater Quality Documentation of Roadside Shoulders Borrow Ditches: A Summary	Center for Transportation Research, The University of Texas at Austin, Project Summary Report 0-4605-S	Report	Barrett, M.E. (UT Austin, Center for Transportation Research)	Oct-05	TX	6	Filter Strip	3 sites in Austin and 3 in College Station with samples collected at 4 distances. More detailed report needed to enter data.	

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Water Quality and Hydraulic Properties of the Permeable Friction Course	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009: Great Rivers, Kansas City, MO, RI, May 17-21, 2009. S. Starrett, ed.	Conference	Barrett, Michael, Brandon Klenzendorf, Brad Eck, and Randall Charbeneau (UT Austin)	2009	TX	2*	Permeable Pavement	See Eck et al. 2010 for basis of entered data set.	
Product Evaluation: StormFilter - Curituck, NC	Manufacturer (Contech)	Contech Report	Battiata, J., J. Pedrick, S. De Ridder (Contech)	Sep-06	NC	1	Manufactured Device	StormFilter	Yes
Stormwater treatment: do constructed wetlands yield improved pollutant management performance over a detention pond system?	Water Science & Technology Vol 44 No 11-12 pp 565–570	Journal	Bavor, H.J., C.M. Davies and K. Sakadevan	2001	Australia (Univ. of Western Sidney	2	Wetlands/Detention Pond		
Survey of Retention Basin Hydraulic Performance in Florida	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2010: Challenges of Change Providence, RI, May 16-20, 2010. R.N. Palmer, ed.	Conference	Bean, E. Z. and M. D. Dukes (NC State)	2010	FL	40*	Bioretention	Infiltration testing only.	
A Monitoring Field Study of Permeable Pavement Sites in North Carolina. North Carolina State University		Report	Bean, E., W. Hunt, and D. Bidelspach	2004	NC	2*	Porous Pavement	Cary +Goldsboro	
Study of the Surface Infiltration Rates of Permeable Pavements	1st Water and Environment Specialty Conference of the Canadian Society for Civil Engineering	Conference	Bean, E.Z., W.F., Hunt, Bidelspach, Burak (NC State)	Jun-04	MD/DE/NC	1 27*	Permeable Pavement	Most sites are infiltration tests only. 1 site in Goldsboro was monitored for storms and includes water quality.	
Colloidal speciation of heavy metals in runoff and interstitial waters of a retention/infiltration pond	Water Science & Technology Vol 54 No 6-7 pp 307–314	Journal	Béchet, B., B. Durin, M. Legret and P. Le Cloirec	2006	Nantes, France	1	Retention/infiltration pond		
Experience in the Application of Permeable Interlocking Concrete Paving in Australia	9th International Conference on Concrete Block Paving. Buenos Aires, Argentina.	Conference	Beecham, S., D., Pezzaniti, B. Myers, B. Shackel, and A. Pearson	2009	Australia	10*	Permeable Pavement	Infiltration measurements and inspections for pavements in service for approx. 10 years. Not actual stormwater measurements.	
Assessment of the Pollutant Removal Efficiencies of Delaware Sand Filter BMPs	US DOT Online: http://www.fhwa.dot.gov/environment/ultraurb/5mcs3.htm	Report	Bell, W., L. Stokes, L.J. Gavan, and T.N. Nguyen	1995	VA	2*	Sand Filter	Alexandria	Yes (prior to fall 2010)
Greenroof Runoff Water Quality.	Greening Rooftops for Sustainable Communities 2007. Minneapolis, Minnesota.	Conference	Berghage, R., D. Beattie, A. Jarret, and T. O'Connor	2007		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Quantifying evaporation and transpirational water losses from green roofs and green roof media capacity for neutralizing acid rain.	World Green Roof Congress in Basel Switzerland. University Park, Pennsylvania: Pennsylvania State University.	Conference	Berghage, R.D., D.J. Beattie, A.R. Jarrett, F. Rezaei, and A. Nagase.	2005		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Green Roofs for Stormwater Runoff Control	USEPA Office of Research and Developemment	Report	Berghage, Robert D., David Beattie, Albert. R. Jarrett, Christine Thuring, Farzaneh Razaei, and Thomas P. O'Connor	2008	PA	1	Green Roof		Yes

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
A Study of Green Roof Hydrologic Performance in the Cascadia Region	2008 International Low Impact Development Conference	Conference	Berkompas, Bryan, Kurt W. Marx, Heidi M. Wachter, Doug Beyerlein, and Bob Spencer	2008	WA	5*	Green Roof	Work being conducted for Seattle Public Utilities. Data expected to be available for BMP Database at end of 2011.	
Surface Infiltration Rates of Permeable Surfaces: Six Month Update (Nov 2009-Apr 2010), June 2010	U.S. EPA Office of Research and Development National Risk Management Research Laboratory	Report	Borst, M., Rowe, E., Stander, T. O'Conner (EPA - Office of Research & Development)	2010	NJ	3	Permeable Pavement	Edison Evirn. Center Prkng Lot	
Long-Term Stormwater Quantity and Quality Performance of Permeable Pavement Systems.	Center for Water and Watershed Studies, University of Washington.	Report	Brattebo, B. and D. Booth	2003	WA	3	Porous Pavement	Gravelpave; Turfstone, Grasspave; UNI Eco-stone	
Long-term stormwater quantity and quality performance of permeable pavement systems.	Water Research 37(18): 4369-4376.	Journal	Brattebo, B. O. and D. B. Booth	2003		1 or more	Permeable Pavement	Need to obtain and review paper. Reference identifed by CWP.	
Impact of Maintenance and (Im)Properly Sizing Bioretention on Hydrologic and Water Quality Performance	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Brown R. and W. Hunt (NC State)	2010	NC	2	Bioretention	Nashville, NC Walmart site	
Bioretention Performance in the Upper Coastal Plain of North Carolina	2008 International Low Impact Development Conference	Conference	Brown, R. A. and W. F. Hunt (NC State)	2007	NC	4*	Bioretention	Rocky Mount and Nashville See Brown and Hunt 2010 and Brown et al. 2009 to avoid double-counting	
Characterization of Solids Removal and Clogging Processes in Two Types of Permeable Pavement	Thesis, University of Calgary	Thesis	Brown, C.R.	2007	Calgary, Canada	2	Permeable Pavement		
Construction and Performance of Bioretention Cells	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009: Great Rivers, Kansas City, MO, RI, May 17-21, 2009. S. Starrett, ed.	Conference	Brown, G. O., R. A. Chavez, D. E. Storm, and M. D. Smolen	2009	OK	10	Bioretention		
Bioretention/Bioinfiltration Performance in the Mid-Atlantic	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009: Great Rivers, Kansas City, MO, RI, May 17-21, 2009. S. Starrett, ed.	Conference	Brown, R. A., W. F. Hunt, A. P. Davis, R. G. Traver, and J. M. Olszewski (NC State)	2009	MD, PA, NC	4*	Bioretention	1 site already in BMP Database, others are not (2 in Rocky Mount, NC, 1 in Silver Spring MD)	
California Department of Transportation, Division of Environmental Analysis. BMP retrofit pilot program.	Final Report CTSW-RT-01-050. January, 2004.	Report	Caltrans	2004	CA	*	Multiple	Already included in BMP Database	Yes (prior to fall 2010)
Product Evaluation: Performance of the Volume StormFilter Relative to State of Maine Performance Goals for Treatment of Total Phosphorus and Total Zinc: Zeolite and Alumina Media	Manufacturer (Contech)	Contech Report	Calvert, P. and S. de Ridder	June-08	ME	1	Manufactured Device	StormFilter	Yes

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Capital Region Watershed District Stormwater BMP Performance Assessment and Cost-Benefit Analysis, January 22, 2010.		Report	Capitol Region Watershed District	2010	MN	19	1-wetland system 1-infiltration/storage 1-regional pond 8-infiltration trenches 8-rain gardens	For purposes of entry into BMP Database, 2 of these sites meet	Yes
Impact of Engineered Soil Characteristics on Bioretention Cell Performance	Journal of Hydrologic Engineering (paper accepted)	Journal	Carpenter, Donald D., and L. Hallam	2009	MI	1	Bioretention	**Dr. Carpenter expressed interest in providing data, but the information transfer was not completed within the timeframe of this literature review*	
The Lawrence Technological University Greenroof Performance Evaluation Project	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009	Conference	Carpenter, Donald D., and Preethi Kaluvakolanu	2009	MI	1	Green Roof	10000 sq ft, Southfield **Dr. Carpenter expressed interest in providing data, but the information transfer was not completed within the timeframe of this literature review*	
Effect of Roof Surface Type on Stormwater Runoff from full Scale Roofs in a Temperate Climate.	Journal of Drainage and Engineering (publication/acceptance date unknown)	Journal	Carpenter, Donald D., and Preethi Kaluvakolanu	2009	MI	1*	Green Roof	May overlap with conference paper by Carpenter and Kaluvakolanu	
Center for Watershed Protection and Chesapeake Stormwater Network Appendix F--BMP Research Summary Tables	Center for Watershed Protection	Report	Center for Watershed Protection	2009	-	-	-	Appendix lists references for many BMP studies. Some studies already in BMP Database, others are not and have been included in this literature review.	
Tech Mem. 1 - Literature Review: Research in Support of an Interim Pollutant Removal Rate for Street Sweeping & Storm Drain Cleanout Activities	Center for Watershed Protection	Report	Center For Watershed Protection	Oct-06	CA/WI/NC/IL/WA	Literature Review	Street Sweeping/Storm Drain Cleaning	May be used to identify street sweeping studies with quantitative data; only a few identified; some overlap with existing studies in BMP Database.	
Tech Mem. 2 - Summary of Municipal Practices Survey: Research in Support of an Interim Pollutant Removal Rate for Street Sweeping & Storm Drain Cleanout Activities	Center for Watershed Protection	Report	Center For Watershed Protection	Oct-06	MD	Survey of 20 MS4s in Chesapeake Bay	Street Sweeping/Storm Drain Cleaning	Water quality data not included, but useful information on street sweeping practices.	
Center for Watershed Protection Pollutant Removal Performance Database Version 3	Center for Watershed Protection	Report/Database	Center for Watershed Protection; McNeil, Lisa 2010 [updates Sept 2007, Winer, R. 2000 and Schueler, T. and W. Brown 1997] (Center for Watershed Protection)	2007	US	See notes	Multiple	1st Edition: 123 studies; 2nd Edition 139 studies; 3rd Edition added 27 studies; version provided 10/10 166 studies;	
Pervious Pavement Systems in Florida – Research Results	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Chopra, Manoj, B. Erik Stuart, and Martin P. Wanielista	2010	FL	5*	Permeable Pavement	Infiltration testing using synthetic storms	

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Considerations in Selecting a (Bio)filtration Media to Optimize Lifespan and Pollutant Removal	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Clark, Shirley and Robert Pitt (Penn State and U. Alabama)	2010	--	--	Biofiltration Media	Studies based on lab tests. (*Note: BMP Database does not currently analyze studies resulting from synthetic storms or lab research.)	
Jordan Cove Watershed Project Final Report	University of Connecticut	Report	Clausen, J.C.	2007	CT	1-LID 6-Permeable Pavement 1-Source Control (lawn nutrients)	Site-scale LID study	Site-scale LID, as well as two replicates each of asphalt, UNI group EcoStone ® interlocking concrete pavers, and crushed stone at 6 driveways; lawn nutrient survey ***Permission granted to include data; data not yet entered due to data formatting issues*** Also multiple journal pubs by Bedan and Clausen 2009, Dietz and Clausen 2005, 2006 and 2008, Hood, Clausen and Warner 2006 and 2007, Gilbert and Clausen 2006,	
Green roof research in British Columbia: An overview.	Proc. of 3rd North American Green Roof Conference: Greening rooftops for sustainable communities, Washington, DC: 4–6.	Conference	Connelly, M. and K. Liu	2005	B.C., Canada	1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Product Evaluation: Vortechs 5000 - Covington, GA	Manufacturer (Contech)	Contech Report	Contech	2010	GA	1	Manufactured Device	interlocking concrete pavers, and crushed stone	
NJCAT Technology Verification: StormFilter - Greenville Yards, NJ	Manufacturer (Contech)	Contech Report	Contech	2007	NJ	1	Manufactured Device	StormFilter	Yes
NJCAT Technology Verification - High Efficiency Continuous Deflective Separator - Contech	Manufacturer (Contech)	Contech Report	Contech	Jan-10	NJ	1	Manufactured Device	Continuous Deflective Separator (CDS)	Yes
NJCAT Technology Verification: Media Filtration System 2010 - Contech Construction Products	Manufacturer (Contech)	Contech Report	Contech	Jan-10	OR	1	Manufactured Device	Media Filtration System (MFS)	Yes
Product Evaluation: StormFilter - Lake Stevens: Washington	Manufacturer (Contech)	Stormwater 360 [Contech Report]	Contech	Feb-06	WA	1	Manufactured Device	StormFilter	
Nutrient removal from eutrophic lake water by wetland filtration	Ecological Engineering Volume 19, Issue 2, August 2002, Pages 141-159	Journal	Coveney, M. F., D. L. Stites, E. F. Lowe, L. E. Battoe and R. Conrow	2002	FL	1	Wetlands	Lake Apopka, St. John's River WMD	
Optimization of Bioretention design for Water Quality and Hydrologic Characteristics.	Final Report to Prince George's County, MD. Report 01-04-31032	Report	Davis, A. M. Shokohian, H. Sharma and C. Minami	1998	MD	1*	Bioretention	Synthetic stormwater on field site compared to lab test; Inglewood study in Largo, MD	
Product Evaluation: StormFilter - Target Store: Sacramento, CA	Manufacturer (Contech)	Contech Report	de Rider, S.A. and J. Lehman	Mar-08	CA	1	Manufactured Device	StormFilter	
Bioretention Outflow: Does it Mimic Non-Urban Watershed Shallow Interflow?	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	DeBusk, K. M., W. F. Hunt, and D. E. Line (NC State)	2010	NC	4*	Bioretention	Sites already included in BMP Database	Yes (prior to fall 2010)
Stormwater mitigation and surface temperature reduction by green roofs.	Transactions of the ASAE 48(4): 1491-1496.	Journal	DeNardo, J. C., A. R. Jarrett, et al.	2005		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Green Roof Mitigation of Stormwater and Energy Usage.	ASAE Meeting Paper No. 032305. St. Joseph, Michigan: ASAE.	Conference	DeNardo, J. C., A.R. Jarret, H.B. Manbeck, D.J. Beattie, and R.D. Berghage	2003		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping & Storm Drain Cleanout Programs in Chesapeake Bay Basin		Report	DiBlasi, Ghosh, N. Law (Center for Watershed Protection)	Sep-08	MD	2	Street Sweeping/ Storm Drain Cleaning	Watershed 263 -Baltimore	
Hydrologic and Water Quality Performance of Porous Pavers on Easy Street in Ann Arbor, MI	Uni-Group USA (manufacturer)	Paper	Dierks, S. and S. McIlroy	2010	MI	1	Permeable Pavement	Additional information needed.	
Saturation to Improve Pollutant Retention in a Rain Garden	Environ. Sci. Technol., 2006, 40 (4), pp 1335–1340	Journal	Dietz, Michael E. and John C. Clausen	2006	CT	2	Bioretention	Haddam Unsaturated and Saturated Rain Gardens	
Stormwater runoff and export changes with development in a traditional and low impact subdivision	Journal of Environmental Management	Journal	Dietz, Michael E. and John C. Clausen	2007	CT	*	Site-scale LID study	*See Jordan Cove Final Report, Clausen 2007	
Report as of FY2008 for 2008AL67B: "Evaluating Bioretention Contaminant Uptake and Removal in an Experimental Rain Garden Study"		Report	Dougherty, Mark, C. LeBleu, and E. Brantley (Auburn University)	2008	AL	2*	Bioretention	Controlled field experiments with 900 gal of runoff stored in tanks pumped to cells.	
Monitoring of a Pervious Pavement/Bioswale Infiltration System in Co	StormCon 2009	Conference	Earles, T. Andrew, Jennifer Keyes, and Eliot Wong	2008	CO	2	1-Permeable Pavement 1-Bioretention		
Water Quality of Drainage from Permeable Friction Course	Environmental Science and Technology (submitted August 2010)	Journal	Eck, Bradley, Ryan Winston, Bill Hunt, and Michael Barrett (UT-Austin and NC State)	2010	TX	7	Permeable Pavement	Permeable Friction Course: 3 sites in TX and 4 in NC; only TX studies entered into database	Yes
Hydrologic and Water Quality Aspects of Using a Compost/Mulch Blend for Erosion Control	Journal of Irrigation and Drainage Engineering, Volume 136, Issue 9, pp. 646-655 (September 2010)	Journal	Eck, Bradley, Michael Barrett, Anne McFarland, and Larry Hauck (UT Austin)	2010	TX	Erosion/ Sediment Control	Erosion/ Sediment Control	Parker County; Misc -Compost/Mulch	
Effect of Using Conventional and Controlled Release Fertiliser on Nutrient Runoff from Various Vegetated Roof Systems.	Ecological Engineering, 29, 260-271.	Journal	Emilsson, T., J.C. Berndtsson, J.E. Mattson, and K. Rolf	2007		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Fabco Industries, Inc. Stormbasin Vehicle Refueling/Storage Lot Test Program	Fabco Industries (manufacturer)	Report	Emma, L. and J. Markee	2006	NY	2	Manufactured Device	Additional information needed.	
Fabco Industries, Inc. Beach/Harbor Stormwater Test Program	Fabco Industries (manufacturer)	Report	Emma, L. and J. Markee	2006	NY(?)	1	Manufactured Device	StormBasin. Additional information needed.	
Fabco Industries, Inc. Stormbasin Nutrients: P & N Test Program	Fabco Industries (manufacturer)	Report	Emma, L., J. Markee and J. Peters	2008	NY	3	Manufactured Device	Additional information needed.	
Separation and Handling of Gross Solids and Other Pollutants with Minimal Maintenance	StormCon 2009	Conference	Esmond, S., R. Weir, T. Harris		TX	1	Manufactured Device	Study provided by manufacturer. Device focuses on gross solids. Additional information needed.	
Extensive Living (Green) Roofs for Stormwater Mitigation, Part 2: Performance Monitoring Progress Report	Auckland Regional Council Environmental Research	Report	Fassman, E., R. Simcock, and E. Voyde	2010	Auckland, New Zealand	4	Green Roof	Permission granted for data entry.	
Permeable Pavement Performance Over 3 Years of Monitoring	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Fassman, Elizabeth A. and Sam Blackbourn (U. of Auckland)	2008	Auckland, New Zealand	1*	Permeable Pavement	200 m2 Area [*Used journal-published data set for data entry]	

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Urban Runoff Mitigation by a Permeable Pavement System over Impermeable Soils	Journal of Hydrologic Engineering, June 2010	Journal	Fassman, Elizabeth A. and Samuel Blackbourn (U. of Auckland)	2010	Auckland, New Zealand	1	Permeable Pavement	Over Impermeable soils	Yes
Stormwater Mitigation through a Treatment Train	Auckland Regional Council Technical Report.	Report	Fassman, Elizabeth A., Mingyang Liao, Somayeh Torbati, and Richard Greatrex (U. of Auckland)	2010	Auckland, New Zealand	4	Swale, StormFilter, Wetland, Overall System	Data collection completed for only one of the BMPs at this time.	Yes
Estimation of Green Roof Evapotranspiration – Experimental Results	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Feller, Meghan, Robert Traver, and Bridget Wadzuk (Villanova U.)	2010	PA	1	Green Roof	Data collection still in progress	
Performance Assessment of MTOs Rouge River, Highway 40, Stormwater Management Pond.	SWAMP. Ontario Ministry of Environment and Energy.	Report	Fellows, D.; W. Liang; S. Ristic; and M. Thompson	1999	Ontario, Canada	1	Wet Extended Detention Pond	Rouge River	
Performance Assessment of Richmond Hill's Harding Park Stormwater Retrofit Pond.	SWAMP. Ontario Ministry of Environment and Energy.	Report	Fellows, D.; W. Liang; S. Ristic; and S. Smith	1999	Ontario, Canada	1	Wet Extended Detention Pond	Harding Park	
Stormwater Quality Characteristics in Detention Basins	Journal of Environmental Engineering, Volume 109, Issue 2, pp. 428-447 (April 1983)	Journal	Ferrara, Raymond A. and Patrick Witkowski	1983	NJ	1	Detention Pond		
Multi-Chambered Treatment Train (MCTT) for Treating Stormwater Runoff	Journal of Nanchang University (Engineering and Technology), Vol. 31 Sec. Issue. March	Journal	Field, R., A. Tafuri, J. Y. Lin, and S. L. Yu	2009	Taiwan	1	Manufactured Device		Yes
The Effectiveness of Dry and Wet Stormwater Detention Basins as Sediment and Nutrient Processors	Watershed 2005	Conference	Fortunato, Caroline, Owen McDonough, and Randy Chambers	2005	VA	3	1 Retention/2 Detention Ponds	(1 wet, 2 dry)	
Effectiveness of Environmentally Sensitive Site Design and Low Impact Development on Storm Water Runoff Patterns at Partridgeberry Place Subdivision in Ipswich, MA		Report	Geosyntec Consultants and MA Department of Conservation and Recreation	2009	MA	1	Site-scale LID study		Yes
Performance Testing of Vegetative Filter Strips	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2001	Conference	Gharabaghi, B., R. P. Rudra, H. R. Whiteley, and W. T. Dickinson	2001	Guelph, Ontario, Canada	1*	Filter Strip	"field experiments"; need to further review report for study conditions and number of filter strips	
Evaluation of a Parking Lot Bioretention Cell for Removal of Stormwater Pollutants.	Transactions on Ecology and the Environment. Vol. 81. WIT Press.	Journal	Glass, C. and S. Bissouma	2005	Washington, DC	1	Bioretention	Navy Yard	
Performance of pervious pavement parking bays storing rainwater in the north of Spain	Water Science & Technology, Vol 62 No 3 pp 615–621	Journal	Gomez-Ullate, E., J. R. Bayon, S. Coupe and D. Castro-Fresno	2010	Santander, Spain	45	Permeable Pavement		
Performance of retrofitted stormwater extended detention wetlands.	Proceedings of the ASCE World Environmental and Water Resources Congress. May 15-19, 2007, Tampa, FL.	Conference	Guo, Qizhong	2007		1 or more	Detention Pond	Need to obtain and review paper. Reference identifed by CWP.	
Reductive characteristics of washed-off pollution loads by best management practices	Water Science & Technology, Vol 58 No 12 pp 2339–2346	Journal	Ha, Sung Ryong and Seung Chul Lee	2008	Korea	2	Not specified	Additional information needed.	

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Pierson Pond, Final Report – Stormwater Treatment Capabilities.	Report from North Carolina State University Department of Biological and Agricultural Engineering to City of Charlotte Stormwater Services.	Report	Hathaway, J.M., W.F. Hunt, A. Johnson, and J.T. Smith	2007		1	Retention Pond		
Shade Valley Pond, Final Report – Stormwater Treatment Capabilities.	Report from North Carolina State University Department of Biological and Agricultural Engineering to City of Charlotte Stormwater Services.	Report	Hathaway, J.M., W.F. Hunt, A. Johnson, and J.T. Smith	2007		1	Retention Pond		
Treatment performance of gravel filter media: implications for design and application of stormwater treatment systems	Water Research 41 (2007) 2513-2524	Journal	Hatt, B.E., T. D. Fletcher, and Ana Deletic	2007	Australia	1*	Infiltration Trench	Gravel infiltration filter; synthetic storm simulations only	
Final Project Report: Compost-Amended Vegetated Filter Strip Performance Monitoring Study		Report	Herrera Environmental Consultants (for Washington State DOT)	2009	WA	1 or more	Filter Strip		
Sun Valley Park Storm Water Infiltration Basin Demonstration Project	ASCE-EWR Proceedings of the 2005 World Water and Environmental Resources Congress, May 15-19, 2005, Anchorage, Alaska; Sponsored by Environmental and Water Resources Institute (EWRI)of the American Society of Civil Engineers	Conference	Higgins, K. and C. Roth	2010	CA	1	Infiltration Basin	Water quality data provided electronically with study fact sheet. Additional supporting information being pursued.	Yes
Flow Control and Water Quality Treatment Performance of a Residential Low Impact Development Pilot Project In Western Washington	Final Report for WERF	Report	Hinman, Curtis	2010	WA	5	1-LID Site Scale 4-Bioretention at site (flow)	8.3-acre Site includes bioretention swales, permeable concrete, compost amended soils, surface flow dispersion (Also in LID 2010 conference proceedings)	
The Extreme BMP Makeover: A Performance Survey of 200 Stormwater BMPs	StormCon 2009	Conference	Hirschman, D. and L. Woodworth	2008	VA	-*	Multiple	200 BMPs qualitatively evaluated for performance based on a ranking resulting on field inspections rating a variety of characteristics	
Monitoring the Hydrologic Effects of an Extensive Green Roof	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009: Great Rivers, Kansas City, MO, RI, May 17-21, 2009. S. Starrett, ed.	Conference	Holloway, Nathaniel Hanna, Charles J. Werth, and Arthur R. Schmidt	2008	IL	1	Green Roof		
Quantifying Load Reductions of Selected Pollutant Parameters Through the Use of Stormwater Best Management Practices in the Delaware Portion of the Christina Basin	Institute for Public Administration, College of Education and Public Policy, University of Delaware	Report	Homsey, Andrew R., Martha Corrozi Narvaez, Erika D.Farris, and Maureen Nelson	Aug-09	DE	none; modeling only	Dry/Wet Ponds	Closer review of paper indicates modeling only; For Christina Basin bacteria and nutrient TMDLs; http://dspace.udel.edu:8080/dspace/handle/19716/4294	
Effectiveness of a Pressurized Stormwater Filtration System in Green Bay, Wisconsin: A Study for the Environmental Technology Verification Program of the U.S. Environmental Protection Agency	USGS in Cooperation with Wisconsin Department of Natural Resources, USGS Scientific Investigations Report 2004-5222	Report	Horwatich, J.A., S.R. Corsi, and R.T. Bannerman	2004	WI	1	Manufactured Device	Arkal Filtration system, Zeta Technologies	Yes

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Parking Lot Runoff Quality and Treatment Efficiency of a Stormwater-Filtration Device, Madison, Wisconsin, 2005–07	USGS in Cooperation with Wisconsin Department of Transportation and Wisconsin Department of Natural Resources, USGS Scientific Investigations Report 2009-5196	Report	Horwatich, J.A., S.R. Corsi, and R.T. Bannerman	2009	WI	1	Manufactured Device		Yes
Examinations of Pervious Concrete and Porous Asphalt Pavements Performance for Stormwater Management in Northern Climates	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Houle, Kristopher M., Robert M. Roseen, Thomas P. Ballestero, Joshua F. Briggs, and James J. Houle (U. New Hampshire Stormwater Center)	2007-2008	NH	2	Permeable Pavement		
Evaluation of Bioretention for Treatment of Urban Storm Water Runoff	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2003	Conference	Hsieh, Chi-hsu and Allen P. Davis	2003	MD	6*	Bioretention	Simulated Runoff	
Evaluating Bioretention Areas from Two Field Sites in North Carolina	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2004	Conference	Hunt, W. F. and A. R. Jarrett (NC State)	2004	NC	2*	Bioretention	Greensboro Site-already included in BMP Database	Yes (prior to fall 2010)
Evaluating Bioretention Hydrology and Nutrient Removal at Three Field Sites in North Carolina.	Journal of Irrigation and Drainage Engineering. Vol. 132(6):600-608	Journal	Hunt, W., A. Jarrett, J. Smith, and L. Sharkey	2006	NC	3*	Bioretention	Chapel Hill Cell C1	
Low Impact Development Benefits of Level Spreader – Vegetative Filter Strip Systems	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Hunt, W.F. and R. Winston (NC State)	2010	NC	2*	Level Spreaders for Veg. Strips	Apex and Louisburg Sites. See Winston, Hunt et al. Entered into BMP Database	*
Hydrologic and Water Quality Performance From Green Roofs in Goldsboro and Raleigh, NC		Report	Hunt, W.F., A. Moran, and J. Smith (NC State)	2004	NC	2	Green Roof		
Pollutant Removal and Peak Flow Mitigation by a Bioretention Cell in Urban Charlotte, NC	Environmental Engineering, Vol. 134, Issue 5, May 2008	Journal	Hunt, W.F., J.T. Smith, S.J. Jadlocki, J. M. Hathaway, P.R. Eubanks (NC State)	2008	NC	1*	Bioretention	Charlotte {?Hal Marshall}	Yes (prior to fall 2010)
Hydrologic and Water Quality Evaluation of Four Permeable Pavements in North Carolina, USA	9th International Conference on Concrete Block Paving. Buenos Aires, Argentina.	Conference	Hunt, W.F., K.A. Collins and J.M. Hathaway	2009	NC	4	Permeable Pavement	Kingston site	Yes
Effect of a Decentralized Rainwater Management System in Korea Apartment Complex	Water Practice & Technology © IWA Publishing 2008	Journal	Hyun, Kyung-Hak, Jeong-Ik Oh, Sung-Sick Ahn and Joung-Joo Choi (Environment and Energy Research Team, Housing & Urban Research Institute, Korea National Housing Corporation)	2008	Yongin, Korea	1	Rainwater Storage/ Infiltration Barrel/ Infiltration Trench		

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Runoff and infiltration characteristics of pavement structures—review of an extensive monitoring program	Water Science & Technology Vol 56 No 10 pp 133–140	Journal	Illgen, M., K. Harting, T.G. Schmitt and A. Welker (Institute of Urban Water Management, University of Kaiserslautern, Germany)	2007	Germany	Several (up to 160)	Permeable Pavement	Study purpose to general a broad database with over 160 field and lab scale experiments for surface runoff and infiltration characteristics.	
Evaluation of CDS Technologies, Inc. Media Filtration System, Data Validation Report and Technical Evaluation Engineering Report Summary	Manufacturer (Contech)	Contech Report	James, Roger (Water Resources Management)	June-06	WA	1	Manufactured Device	Media Filtration System (MFS)	Yes
Assessing the performance of urban BMPs in Scotland	Water Science & Technology, Vol 39 No 12 pp 123–131	Journal	Jefferies, C., A. Aitken, N. McLean, K. Macdonald and G. McKissock	2000	Scotland	*	Multiple	Paper appears unlikely to have monitoring data, but has information on 100 source control and end of pipe BMPs in Scotland and outlines a program that would likely include monitoring; additional follow-up would be needed for this data set.	
Fines Accumulation and Distribution in a Stormwater Rain Garden Nine Years Post Construction	Journal of Irrigation and Drainage Engineering	Journal	Jenkins, Jennifer K. Gilbert, Bridget M. Wadzuk, and Andrea L. Welker	2009	PA	1	Bioretention		
The Effect of Urban Stormwater BMPs on Runoff Temperature in Trout Sensitive Waters	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2007	Conference	Jones, Matthew P., William F. Hunt, and Jonathan T. Smith	2007	NC	6*	4 bioretention 1 stormwater wetland 1 wet pond	Western NC--need to obtain study to determine whether sites are already included.	
The clogging behaviour and treatment efficiency of a range of porous pavements	11th International Conference on Urban Drainage, Edinburgh, Scotland	Conference	Jong, C.F., A. Deletic, T.D. Fletcher, and M.R. Grace	2008	Australia	3*	Permeable Pavement	Synthetic storms; study provided by PermaPave	
Bioretention Cell Efficacy in Cold Climates	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Khan, U. T. C. Valeo, A. Chu, and B. van Duin	2010	Calgary, Canada	1*	Bioretention	Synthetic runoff conditions	
Flow Monitoring of Three Ecoroofs in Portland, Oregon	2008 International Low Impact Development Conference	Conference	Kurtz, Tim	2008	OR	3*	Green Roof	See Kurtz 2010 for most recent data. Data sets entered into BMP Database	
Ecoroof Performance Monitoring in Portland, Oregon	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Kurtz, Tim (Bureau of Environmental Services, City of Portland)	2010	OR	3	Green Roof	Portland (Portland Building, Hamilton Ecoroof East and West)	Yes
Glencoe Rain Garden		Unpublished Data	Kurtz, Tim (Bureau of Environmental Services, City of Portland)	2010	OR	1	Bioretention		Yes
Post-Project Monitoring of BMP/SUDS to Determine Performance and Whole Life Cycle Costs: Phase 2	WERF, AwwaRF, UKWIR	Report	Lampe, L., H. Andrews, M. Barrett, C. Jeffries et al.	2005	US& UK	-	-	This document provides a reference list that may contain additional monitoring studies, particularly in the UK.	

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
A Low Impact Development Method for Mitigating Highway Stormwater Runoff - Using Natural Roadside Environments for Metals Retention and Infiltration		Thesis	Lancaster, C.D. (Washington State U.)	2005	WA	3	Filter Strip	"Low Impact Area" --vegetated filter strips on highway road shoulder	
Design and Pollutant Reduction of Vegetated Strips and Swales	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2005	Conference	Lantin, Anna and Michael Barrett	2005	TX	*	Filter Strip/Grass Swales	Caltrans study; already in BMP Database.	Yes (prior to fall 2010)
Catch basin inserts to reduce pollution from stormwater	Water Science & Technology, 2001;44(7):23-34	Journal	Lau, S.L., E. Khan, and M.K. Stenstrom	2001	CA	-	Manufactured Devices	Misc - Catch Basin Inserts {appears to be the Caltrans catchbasin insert study}	Yes (prior to fall 2010)
Hydraulic performance of biofilters for stormwater management: first lessons from both laboratory and field studies	Water Science & Technology Vol 56 No 10 pp 93–100	Journal	Le Coustumer, S., T. D. Fletcher, A. Deletic and S. Barraud	2007	Melbourne, Australia	*	Bioretention	Facility for Advancing Water Biofiltration. Appears to be field and lab experiments. Additional review needed.	
Quantification of Petroleum Hydrocarbon Residual and Biodegradation Functional Genes in Rain Garden Field Sites	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	LeFevre, N.J., Gregory H., Paige J. Novak, and Raymond M. Hozalski	2008	MN	*	Bioretention	Soil samples collected at 56 bioretention sites in MN. Did not involve stormwater sampling.	
Hydrologic Performance Monitoring of an Underdrained Low Impact Development Stormwater Management System	Journal of Irrigation and Drainage Engineering, May 2010, Vol. 136, No. 5	Journal	LeFevre, N.J.B, D.W. Watkins, J.S. Gierke, and J. Brophy-Price	Jul-05	VA	1	LID	1 system in Gainsville	
Effects of a porous pavement with reservoir structure on runoff water: water quality and fate of heavy metals	Water Science & Technology, Vol 39 No 2 pp 111–117	Journal	Legret, Michel and Valérie Colandini	1999	Bouguenais, France	1	Permeable Pavement		
White Paper: Filterra® Bioretention Systems: Technical Basis for High Flow Rate Treatment and Evaluation of Stormwater Quality Performance	Prepared for Americast, Inc.	Report	Lenth, John and Rebecca Dugopolski (Herrera Environmental Consultants) and Marcus Quigley, Aaron Poresky, and Marc Leisenring (Geosyntec Consultants)	2010	VA or WA?	4	Manufactured Device	Filterra	Yes
Water Quality Results--Centinela-Mar Vista Urban Runoff Treatment Project	BioClean Environmental Services, Inc./Modular Wetland Systems, Inc. (manufacturer)	Letter/Power point	Letter from N. Shapiro, City of Santa Monica to G. Kent, Bioclean	2010	CA	1	Manufactured Device	Additional information needed.	
Water Quality Improvement through Reductions of Pollutant Loads Using Bioretention	Journal of Environmental Engineering, Volume 135, Issue 8, pp. 567-576 (August 2009)	Journal	Li, Houng and Allen P. Davis	2009	MD	2	Bioretention	*may overlap with paper with Davis, Hunt, Traver paper	
Engineering performance of rooftop gardens through field evaluation.	Proc. of the 18th International Convention of the Roof Consultants Institute: 93–103.	Conference	Liu, K.	2003		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Thermal Performance of Green Roofs through Field Evaluation.	1st North American Green Roofs Infrastructure Conference, Awards, and Trade Show, Chicago, Il.	Conference	Liu, K. and B. Baskaran	2003		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Evaluation of an Extended Detention Basin at Grant Ranch Development, Denver, Colorado		Report	Loilie, Vivien	2006	CO	1	Detention Pond		Yes

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
LA County Dominguez Gap Wetlands		Unpublished Data	Los Angeles	2010	CA	1	Wetland - Basin With Open Water Surfaces	Water quality data provided electronically with study fact sheet. Additional supporting information being pursued.	Yes
Low Impact Development: A Literature Review	EPA	Report	Low Impact Development Center	2000	-	5+	2-Bioretention 1-Green Roof 1-Permable Pavement various grass swales	Several case studies that may be appropriate for inclusion. FL study already included. BR sites are synthetic/lab tests.	
Innovative NPS Pollution Control Program for Lake Travis in Central Texas. LCRA.	LCRA	Report	Lower Colorado River Authority	1997	TX	3	2 Organic Filters 1 Retention Pond	LCRA Office Complex; McGregor Park; LCRA Office Pond	
Marie Canyon WQ Improvement Project		Unpublished Data	Malibu	2010	CA	1	Manufactured Device	UV Disinfection study. Water quality data provided electronically with study fact sheet. Additional supporting information being pursued.	Yes
Pollutant removal efficacy of three wet detention ponds.	Journal of Environmental Quality. 31: 654-660.	Journal	Mallin, M.A., Ensign, S.H., Wheeler, T.L., and Mayes, D.B.	2002		3	Retention Pond		
Wet Detention Basin Effectiveness Study, Phase II (Natomas)		Report	Mangarella, Peter, Judd Goodman, Kelly Havens, Marc Leisenring, Dan Pankani, Will Lewis, Geosyntec Consultants; Hong Lin, City of Sacramento	2010	CA	1	Retention Pond		Yes
Assessment of stormwater impacts on an urban stream with a detention pond	Water Science & Technology Vol 45 No 3 pp 255–263	Journal	Marsalek, J., Q. Rochfort, L. Grapentine and B. Brownlee (National Water Research Institute)	2002	Ontario, Canada	1	Detention Pond		
Green Roof Hydrologic and Water Quality Performance from Two Field Sites in North Carolina	Watershed 2005	Conference	Moran, A. C., W. F. Hunt, and J. T. Smith (NC State)	2004	NC	2	Green Roof		
A North Carolina Field Study to Evaluate Greenroof Runoff Quantity, Runoff Quality, and Plant Growth. Raleigh, North Carolina: North Carolina State University.		Report	Moran, A.C.	2004		*	Green Roof	*Also see Moran, Hunt and Smith 2004	
Roof Runoff Water Quality - A Comparison of Traditional Roofing Materials	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2010	Conference	Nicholson, Natasha, Shirley E. Clark, Brett V. Long, Christina Y. S. Siu, Julia Spicher, and Kelly A. Steele	2010	PA	*	Green Roof	Laboratory study of roofing materials	
ETV Report, Stormwater Source Area Treatment Device, The Stormwater Management StormFilter Using ZPG Filter Media	Manufacturer (Stormwater Management, Inc.)	Stormwater Management, Inc. [Contech]	NSF International and EPA	Jul-04	WI	1	Manufactured Device	StormFilter	Yes
Winter Bioretention System Infiltration Study	StormCon 2009	Conference	Oberts, G., N.J. LeFevre, and J. Davidson	2003-	MN	4	Bioretention	Note: also published in Davidson et al. 2008a&b; Lefevre et al. 2009. These studies not listed to avoid duplication.	

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Monitoring of a Best Management Practice Wetland before and after Maintenance	Journal of Environmental Engineering, Volume 135, Issue 11, pp. 1145-1154 (November 2009)	Journal	O'Connor, Thomas P. and James Rossi	2009	NY	1	Wetland	Monitored in 2005	
Hydrologic Restoration in the Urban Environment Using Green Roofs	Water 2010, 2, 140-154; doi:10.3390/w2020140	Journal	Palla, Gnecco, Lanza	2010	Genova	1 Site	Green Roof		
Field Study of the Ability of Two Grassed Bioretention Cells to Reduce Stormwater Runoff Pollution	Journal of Irrigation and Drainage Engineering, July/Aug 2009, Vol. 135, No. 4	Journal	Passeport, E., W.F. Hunt, Line, R. Smith, and R. Brown (NC State)	2009	NC	2*	Bioretention	Graham High School	Yes (prior to fall 2010)
Product Evaluation: Manasquan Savings Bank High Efficiency CDS Model PMSU20_25 Field Project Quarterly Performance Summary: October 2007 through April 2008	Manufacturer (Contech)	Contech Report	Pedrick, J. and S. de Ridder (Contech Stormwater Solutions)	Jul-08	NJ	1*	Manufactured Device	Continuous Deflective Separator (CDS). See NJCAT (2010) report for entered data.	
NJCAT Technology Verification: StormVault - New Jersey	Manufacturer (Contech)	Contech Report	Pedrick, J. and S. de Ridder (Contech)	Aug-07	NJ	1	Manufactured Device	StormVault	Yes
Long-Term Effectiveness of a Bioretention System Treating Road Runoff in Northeastern Kansas	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009	Conference	Peltier, Edward, Xiaolu Chen, Kelly Kindscher, and C. Bryan Young	2008	KS	1	Bioretention		
Environmental Technology Verification Report Stormwater Source Area Treatment Device The Terre Hill Concrete Products Terre KleenTM 09	Manufacturer	Report	Penn State Harrisburg	2008	PA	1	Manufactured Device		Yes
Fabco Industries, Inc. Stormbasin Filter Cartridge Test Report: Clean Flow Rate Oil and Grease Effectiveness	Fabco Industries (manufacturer)	Report	Peters, J., L. Emma and J. Markee	2006	NY	1*	Manufactured Device	*Lab tests. StormBasin. Additional information needed.	
Road runoff management using over-the-shoulder infiltration: real-scale experimentation	Water Science & Technology, Vol 60 No 6 pp 1575–1587	Journal	Piguet, P., A. Parriaux and M. Bensimon	2009	Switzerland	5	Bioretention	Infiltration into engineered embankment slopes on highways	
Infiltration Through Disturbed Urban Soils and Compost-Amended Soil Effects on Runoff Quality and Quantity	U.S. EPA Urban Watershed Management Research	Report	Pitt, R. E., J. Lantrip, R. Harrison, T.P. O'Connor (EPA Urban Watershed Management Research and U. of Alabama)	1999	AL	-	Infiltration Testing - Compost Amended Soil; not specific BMP tests	*Also see Pitt et al. 2001 for conference paper.	
Infiltration Through Compacted Urban Soils and Effects on Biofiltration Design	Low Impact Development Roundtable Conference, Baltimore, MD, July 2001	Conference	Pitt, R. E., S. Chen, and S. Clark	2001	AL	-	Infiltration - Compact Soils	*Also see Pitt et al. 1999 for full report.	
Urban Stormwater Reduction and Quality Improvement Through the Use of Permeable Pavements.	Water Science and Technology WSTED 4 21(8/9).	Journal	Pratt, C. J., J. D. G. Mantle, et al.	1989		1 or more	Permeable Pavement	Need to obtain and review paper. Reference identifed by CWP.	
Revised Restoration/Management Plan for Lake Luxembourg/Core Creek Watershed, Core Creek Park, Bucks County, PA	Snout (manufacturer)	Report	Princeton Hydro, LLC	2005	PA	1	Manufactured Device	Study provided by manufacturer. Additional information needed.	
The use of wetlands for nutrient removal from surface runoff in a cold climate region of California—results from a newly constructed wetland at lake Tahoe	Journal of Environmental Management Volume 36, Issue 1, September 1992, Pages 35-53	Journal	Reuter, John E., Tjut Djohan and Charles R. Goldman	1992	CA	1	Wetlands	Lake Tahoe area; 1987 monitoring	

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Study on the Effectiveness of BMPs to Control Bacteria Loads - Final Report	Texas Commission on Environmental Quality	Report	Rifai, Hnadia (University of Houston)	Jun-05	TX	2-Retention Ponds 2-Detention Ponds	Wet/Dry Basins	Focused on bacteria; also mentions other BMP types	
University of New Hampshire Stormwater Center 2007 Annual Report		Report	Roseen, Robert, Thomas Ballestero, and James Houle (U. New Hampshire Stormwater Center)	2007	NH	*	Multiple	Already included in BMP Database	Yes (prior to fall 2010)
University of New Hampshire Stormwater Center 2009 Biannual Report	University of New Hampshire	Report	Roseen, Robert, Thomas Ballestero, and James Houle (U. New Hampshire Stormwater Center)	2009	NH	*	Multiple	Additional years of data for existing studies in BMP Database	
Permeable pavement monitoring at the Edison Environmental Center demonstration site	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2010: Challenges of Change Providence, RI, May 16-20, 2010. R.N. Palmer, ed.	Conference	Rowe, Amy A., Michael Borst, Thomas P. O'Connor, and Emilie K. Stander	2009	NJ	3*	Permeable Pavement	3 types - 1 Lot. Status of data sets unclear--this is a long-term study. See Borst et al. 2010 for most recent data set.	
Green Roof Research Program at Michigan State		Michigan State Website	Rowe, Brad et al. (Michigan State)	2010	MI	1	Green Roof		
Nutrient Reduction in Stormwater Pond Discharge Using a Chamber Upflow Filter and Skimmer (CUFS)	Water Air Soil Pollut (2010) 208: 385-399	Journal	Ryan, P., M. Wanielista, and N. Chang	2010	FL	1	Media Filter	Permission granted for data entry.	
Evaluation of Storm Water Treatment by Vegetated Areas Adjacent to Highways	International Erosion Control Association (IECA), 34th Annual Conference and Expo., Las Vegas, Nevada, February 24-28, 2003; Also Caltrans Stormwater Program Paper	Conference	Scharff, Misty, Anna Lantin, and David Alderete	2003	CA	8 Sites*	Filter Strip	Already in BMP Database.	Yes (prior to fall 2010)
Evaluation of Turf-Grass and Prairie-Vegetated Rain Gardens in a Clay and Sand Soil, Madison, Wisconsin, Water Years 2004–08	USGS in Cooperation with City of Madison and Wisconsin Department of Natural Resources, USGS Scientific Investigations Report 2010-5077	Report	Selbig, W. R. (U.S. Geological Survey) and N. Balster (University of Wisconsin)	2010	WI	2	Bioretention	Tests in Clay and Sand Soils; flow only	Yes
A Comparison of Runoff Quantity and Quality from Two Small Basins Undergoing Implementation of Conventional and Low-Impact-Development (LID) Strategies: Cross Plains, Wisconsin, Water Years 1999–2005	USGS in Cooperation with Wisconsin Department of Natural Resources, USGS Scientific Investigations Report 2008-5008	Report	Selbig, W.R., and Bannerman, R.T	2008	WI	1	LID System		Yes
Evaluation of street Sweeping as a Stormwater Management Tool in Three residential Basins in Madison, WI	USGS Scientific Investigations Report 2007-5156	Report	Selbig, W.R., and Bannerman, R.T	2008	WI	3	Street Sweeping		
Performance of California Wet Pond	Alameda County Public Works	Report	Shawley, Gary	2005	CA	1	Retention Pond		Yes
Stormwater BMP Monitoring for Performance: The Charlotte Experience	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2005	Conference	Smith, J. T., W. F. Hunt, S. Jadlocki, and P. R. Eubanks (NC State)	2005	NC	12*	Multiple	Charlotte; likely have some but not all of these; need to obtain conference paper. Misc: Wetlands, bioretention, wet ponds, etc.	

Attachment 1. Literature Review Summary

Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Pollutant Removal in Bioretention Cells with Grass Cover	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2007	Conference	Smith, Ryan A. and William F. Hunt (NC State)	2007	NC	2	Bioretention	Piedmont area (not clear whether these sites differ from other NC State studies entered into BMP Database)	
The Effects of Rain Garden Size on Hydrologic Performance	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2010: Challenges of Change Providence, RI, May 16-20, 2010. R.N. Palmer, ed.	Conference	Stander, Emilie K., Michael Borst, Thomas P. O'Connor, and Amy A. Rowe	2009	NJ	6	Bioretention	Studies at USEPA, National Risk Management Research Laboratory, Urban Watershed Management Branch, Edison, NJ	
Field Evaluation of a Stormwater Bioretention Filtration System	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2007	Conference	Stanford, Richard L. and Shaw L. Yu	2005	VA	1	Manufactured Device	Manufactured Bioretention	
Product Evaluation: StormFilter - Heritage Market: Washington	Manufacturer (Stormwater 360)	Report	Stormwater 360	Feb-06	WA	1*	Manufactured Device	StormFilter	Yes (prior to fall 2010)
Ross Park Shelterhouse Green Roof Performance Study Implementation Plan	Seattle Public Utilities	Report	Taylor Associates	2008	WA	3*	Green Roof	*Data not expected to be available until late 2011. Continuous record suitable for modeling work being developed.	
The Stormwater Control Potential of Green Roofs in Seattle	2008 International Low Impact Development Conference	Conference	Taylor, Brian L.	2008	Pacific NW	*	Green Roof	# of roofs monitored not clear from abstract; some involve computer simulations	
Storm water treatment with a wet pond: a case study.	Proceedings of the 2001 Wetlands Engineering and River Restoration Conference, 2001, 323-332.	Conference	Taylor, S., Barrett, M., Borroum, J.S., Currier, B.	2001		1	Retention Pond		
Stormwater runoff treatment by a filtration system and wet pond in Tampa, Florida. Final Report to the	Final Report	Report	Teague, K. and Rushton, B.	2005		1	Filtration System/Wet Pond		
Rainwater Runoff Quantity and Quality Performance from a Greenroof: the Effects of short-term events.	Ecological Engineering, 30, 271-277.	Journal	Teemusk, A. and Ü Mander	2007		1 or more	Green Roof	Need to obtain and review paper. Reference identifed by CWP.	
Product Evaluation: Lolo Pass Road Field Evaluation: Media Filtration System	Manufacturer (Contech)	Contech Report	Telleson, G.	July-06	OR	1*	Manufactured Device	Media Filtration System (MFS) See NJCAT (2010) report for entered data.	
EPA Denver Green Roof		Unpublished Data	U.S. EPA Region (Unpublished data via Greg Davis)	2010	CO	1	Green Roof		Yes
Jordan Cove Urban Watershed Project		Report/Project Website	University of Connecticut	2007	CT	*	Site-scale LID study	*See Jordan Cove Final Report, Clausen 2007	
National Highway Runoff Water Quality Data and Methodology Synthesis: Abstracts of State Reports	USGS and FHWA	Website	USGS/FHWA	Mostly 1980's-90's	-	-	-	Older highway studies listed in one location	
Green Roof Stormwater Retention: Effects of Roof Surface, Slope, and Media Depth.	J Environ Qual 34(3): 1036-1044.	Journal	VanWoert, N. D., D. B. Rowe, J.A. Andresen, C.L. Rugh, R.T. Fernandez and L. Xiao	2005	MI	2+ Roofs 48 Roof Platforms	Green Roof	Also see Michigan State University Green Roof Research Program; also publications by Rowe et al. 2006 and Getter et al. 2007. Ford Motor Company 10. 4 acre extensive green roof site	
Runoff detention effect of a sedum green-roof	Nordic Hydrology Vol 38 No 1 pp 99–105	Journal	Villarreal, Edgar L.	2007	Sweden	1	Bioretention		

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Monitoring the startup of a wet detention pond equipped with sand filters and sorption filters	Water Science & Technology, Vol 60 No 4 pp 1071–1079	Journal	Vollertsen, J., K. H. Lange, J. Pedersen, P. Hallager, A. Bruus, A. Laustsen, V. W. Bundesen, H. Brix, A. H. Nielsen, N. H. Nielsen, T. Wium-Andersen and T. Hvitved-Jacobsen	2009	Denmark	1	Retention Pond	Pond also equipped with sand filters and sorption filters.	
Stormwater Mitigation by Living Roofs in Auckland, New Zealand	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Voyde, Emily, Elizabeth Fassman, and Robyn Simcock (U. of Auckland)	2010	Auckland, New Zealand	1	Green Roof	250 m2 roof	Under Review
Nutrient Loading in a Mature Constructed Stormwater Wetland	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2008	Conference	Wadzuk, Bridget M. and Robert G. Traver (Villanova U.)	2008	PA	1	Wetlands	Monitored in 2007	
A Water Quality Assessment of Two Green Roof Stormwater Treatment Systems	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2008	Conference	Wanielista, M. P., M. Hardin, and M. Kelly	2008	FL	2	Green Roof	1 green roof includes a cistern to irrigate with.	
Hydrologic behaviour of stormwater infiltration trenches in a central urban area during 23/4 years of operation	Water Science & Technology, Vol 39 No 2 pp 217–224	Journal	Warnaars, Eric, Anja Veldt Larsen, Per Jacobsen and Peter Steen Mikkelsen	1999	Denmark	2	Infiltration Trench		
Field Evaluation of Four Level Spreader-Vegetative Filter Strips to Improve Urban Stormwater Quality	Journal of Irrigation and Drainage Engineering (posted ahead of print March 8)	Journal	Winston, R.J., W.F. Hunt, D.L. Osmond, W.G. Lord, and M.D. Woodward (NC State)	2010	NC	4	Filter Strips	Apex and Louisburg Sites	Yes
Evaluation of Roadside Filter Strips, Dry Swales, Wet Swales, and Porous Friction Course for Stormwater Treatment	ASCE-EWRI Conference Proceedings, Low Impact Development 2010: Redefining Water in the City, San Francisco, CA, April 11-14, 2010.	Conference	Winston,R. J. W. F. Hunt, and J. D. Wright (NC State)	2010	NC	2-swales 2-wetland channels	Swales and Permeable Friction Course	Swales (wet & dry); I-40, includes PFC sites identified in Eck et al.; PFC not "counted" in # of BMPs monitored column	
Research of Hydrologic and Water Quality Performance of 4 Linear Wetlands in Eastern North Carolina	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009: Great Rivers, Kansas City, MO, RI, May 17-21, 2009. S. Starrett, ed.	Conference	Wright, J. D. And W. F. Hunt (NC State)	2008	NC	2*	Wetland Channel	*See Winston, Hunt and Wright	
Implementation and Performance of Stormwater Best Management Practice Retrofits in Wilmington, NC	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2009: Great Rivers, Kansas City, MO, RI, May 17-21, 2009. S. Starrett, ed.	Conference	Wright, J. D., W. F. Hunt, M. R. Burchell II, C. A. Perrin, and E. R. McCoy (NC State)	-	NC	4	LID System: Porous Pavement, Raingarden, etc.	Burnt Mill Creek	
Systematic Evaluation of Pollutant Removal by Urban Wet Detention Ponds	Journal of Environmental Engineering, Vol. 122, No. 11, November 1996, pp. 983-988	Journal	Wu, Jy S., Robert E. Holman, and John R. Dorney	1996	NC	3*	Detention Pond	Believed to already be included in the Database	Yes (prior to fall 2010)

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Source Name (paper, database, report title, etc.)	Source	Source Type	Author(s)	Year	State (Location)	# of BMPs	BMP Type(s)	Comment	Entered into BMP Database (Nov 2010)?
Design and hydraulic characteristics of a field-scale bi-phasic bioretention rain garden system for storm water management	Water Science & Technology, Vol 59 No 9, pp 1863–1872	Journal	Yang, H., D. C. Florence, E. L. McCoy, W. A. Dick and P. S. Grewal	2009	OH	1*	Bioretention	Synthetic runoff tests	
Contaminant Detention in Highway Grass Filter Strips	Washington State Transportation Commission	Report	Yonge, David (Washington State University) and E. Molash (WSDOT)	2000	WA	3	Filter Strip	3 test plots on SR-8; unclear whether available for inclusion in the BMP Database; additional follow-up needed.	
Field Test of Grassed-Swale Performance in Removing Runoff Pollution	J. Water Resource. Plng. and Mgmt. Volume 127, Issue 3, pp. 168-171 (May/June 2001)	Journal	Yu, Shaw L., Jan-Tai Kuo, Elizabeth A. Fassman and Henry Pan	2001	VA & Taiwan	2*	Grass Swales	*VA swale likely already included; Taiwan swale is in ag area	
StormVault - Abemarle County, Virginia	Manufacturer (Jensen Precast)	Jensen Precast Report	Yu, Shaw and Jing Li	Jan-04	VA	1*	Manufactured Device	StormVault; already in database	
Field Monitoring and Evaluation of Stormwater Ultra-Urban BMPs	ASCE-EWRI Conference Proceedings, World Environmental and Water Resources Congress 2001	Conference	Yu, Shaw L., Monika D. Stopinski, and Jenny X. Zhen	2001	VA	*	Bioretention/ Vaults	Already in BMP Database.	Yes (prior to fall 2010)

Note: * indicates that the study is not counted among potential new studies for entry to the BMP Database. Representative reasons include: synthetic storm testing only, study already entered into the BMP database, or study also provided in another reference which is considered the primary source. Due to scope and budget limitations, not all references were reviewed in detail and in some cases, additional information is needed to make a determination of whether the study is appropriate for inclusion in the BMP Database or additional processing of the data may be needed.